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(54) Method and system for optimizing the travel performance of a vehicle,preferably a rail vehicle

(57) The present invention provides a method for optimizing the travel performance, such as accelerating, travel at constant speed, slowing and braking, of a vehicle, wherein fixed data of a route for travelling is transferred over a distance from a traffic control to the vehicle at the start of the route for travelling and/or during travelling thereof and is stored in a computing means in the vehicle, wherein dynamic status data such as relate to the distance travelled and/or speed during travelling of the route is recorded and supplied to the computing means and wherein calculations are performed by the computing means in order to provide a recommendation for the travel performance of the vehicle.

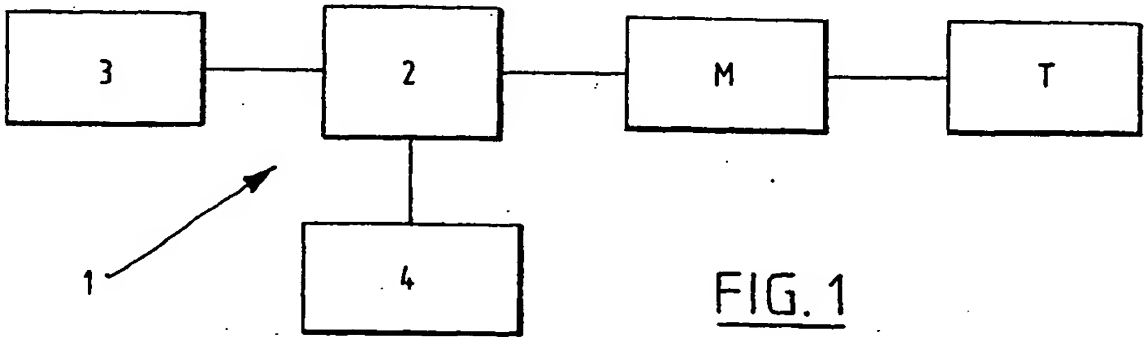

FIG. 1

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Description

In train transport it is of the greatest importance that the timetable is followed punctually. It is of further importance for travel to take place with as little energy consumption and/or wear on the braking members of the rail vehicle as possible. On the basis of the timetable and the route to be covered, Dutch Rail (Nederlandse Spoorwegen N.V.) provides the driver of the rail vehicle with a travel plan for that route, on the basis of which he can travel within the timetable with the least possible energy consumption and/or wear on the braking members.

Such an optimal travel performance can be derived from the article Einfache graphische Behandlung von Fahrprozessen Von Dipl.-Ing. Jörg Müller, Berlin, published in Verkehr und Technik 1994, Heft 10.

However, if changes occur in the standard timetable due to unforeseen circumstances, such as late departure or delays en route, the travel performance of the rail vehicle is left in practice to the experience of the driver. He will ensure first and foremost that the rail vehicle arrives on time. He will probably pay less attention to the energy consumption and/or the wear on the brake members.

In the European patents 0.538.885, 0.615.891, 0.114.633 and 0.467.377, as well as in the PCT publication WO 90/03622 (PCT/AU89/00421) are described computing means in which, starting from a fixed timetable and a route known in advance, curves of the speed as a function of time are calculated in order for example to optimize energy consumption by the drive means for the train and the travelling comfort, while boundary conditions relating to distance, (fixed) timetable and maximum speed are complied with. These known optimizing methods pertain to theoretical simulations, which are based on a fixed timetable.

The European patent application 0.554.983 describes an optimizing method for optimizing travelling time, energy consumption or degree of track utilization when approaching a critical point on the track.

The present invention provides a method for optimizing the travel performance such as acceleration, travel at constant speed, slowing down and braking of a vehicle, wherein fixed data for a route for travelling is transferred from a traffic control over a distance to the vehicle at the start of the route for travelling and/or during travel thereof and is stored in a computing means in the vehicle, wherein dynamic status data such as relate to the distance travelled and/or speed during travelling of the route is recorded and supplied to the computing means, and wherein calculations are performed by the computing means in order to provide a recommendation for a travel performance of the vehicle.

An important advantage of the method according to the present invention relates to enabling a rail vehicle to travel precisely on time, for example with a margin of a half or quarter minute, whereby more efficient use can be made of the available rails and whereby considerable savings can therefore be obtained in the infrastructural works (viaducts etc.) for such rails.

According to the invention commands are sent using radio communication equipment from a central traffic control system to the vehicles making use of the tracks. The commands comprise the route for travelling by the vehicle, in addition to the times and speeds expected at a particular location on the route of the train. The computing means in the vehicle determines the optimum movement of the train on the basis of the commands received. The optimization criteria can include energy consumption, brake wear, technical state of the vehicle and/or the state of the rails (e.g. slippery because of fouling).

Although it is possible to apply the method according to the present invention by driving (and braking) the rail vehicle fully automatically, it is recommended in a first preferred embodiment of the present invention that the driver be informed of the travel recommendation on a display means. If in the future use should be made of a fully automatic drive, it will of course always remain possible for safety reasons for the driver to intervene in the fully automatic system.

The present invention further provides a system for optimizing the travel performance of a vehicle, comprising:

- a computing means provided with storage means for storing fixed data concerning a route for travelling and/or characteristics of the vehicle, which computing means is arranged on board the vehicle;
- measuring means for determining dynamic status data, such as distance travelled and/or speed of the vehicle while travelling the route, wherein the measuring means are connected to the computing means; and
- communication means for transferring the fixed data to the computing means over a distance.

Further advantages, characteristics and details of the present invention will be elucidated in the light of the following description of a preferred embodiment thereof with reference to the annexed figures, in which:

Figure 1 shows a block diagram of the preferred embodiment of the system according to the present invention for performing the method according to the present invention;

Figure 2 shows a block diagram in more detail of the system of figure 1; and

Figure 3 shows a block diagram of a second preferred embodiment of a system according to the present invention for performing the method according to the present invention.

In the preferred embodiment of figure 1 a train T is driven by a driver M. Driver M receives a travel recom-

mendation from a system 1 which comprises a (relatively small) computer 2. The computer 2 is provided on the one hand with one or more memories in which the fixed transport plan data 3 is stored, and is connected on the other hand to means 4 for measuring the location and/or speed of the train. These means 4 can make use of satellite data, but also of sensors for measuring the rotations of shafts of the train.

Figure 2 shows that the computer 2 is supplied with data from a file 5 in which is stored data concerning the route for travelling such as the inclines on the route, the length and the like, with data from a file 6 in which the timetable is stored, with data from a file 7 in which characteristics of the train are stored, such as the number of carriages, the degree of loading and the like, as well as with data from a file 8 in which current route data is stored, for example whether obstructions have recently occurred thereon or whether work is being carried out on the route. In addition, computer 2 receives data in dynamic manner from the means 4 for detecting the speed and location of the train. On the basis of this data the computer 2 on board the vehicle continuously performs calculations, which results in a travel recommendation to the driver of the train, this travel recommendation being shown on a schematically designated display means 9.

At the start of a route the fixed data is entered by the driver into the system 1 according to the present invention, for example using an insertable card, or the data is transmitted from shores to the train. Data for the track, inclines, bends and permitted speeds is stored in a data base. Supplementary information concerning the route and timetable is optionally sent from the traffic control as correction to the stored data base.

In the block diagram of fig. 3 is shown a system 11 which makes use of a computing means 12 connected to measuring means 14 and a display means 19, in addition to data bases 20, 21, 22 and 23, which respectively contain data relating to the track, data concerning the state of the train, data for the timetable and information concerning the route for travelling. Data base 20 is connected to the computing means via an interface 15, while files 21, 22 and 23 are connected to the computing means via interfaces 17, 16 and 18 respectively. The interfaces 16 and 18 remotely receive supplementary information from the central traffic control system at the start of a journey and also preferably during the journey, while the interface 17 is also able to remotely generate information to the central traffic control system. In a first preferred embodiment use is made of GSM systems for the remote communication, while in the future use can of course be made of other systems, wherein use can likewise be made of more reliable systems specially designed for train transport.

On the basis of the plan received from the traffic control and knowledge of its own location and speed the computing means makes a plan for the entire journey or the portion thereof still to be made. Prognoses are herein exchanged between the two. The plan for the train movement is converted by the equipment in the train into commands for controlling the traction and brake installation. The degree of control is of course limited by the maximum safe speed.

The train regularly reports its position to the traffic control system. In the case of conflict with the formulated plan, the system on board the train (the computing means) will attempt to resolve this conflict by making a new plan for the further course of the journey. In the case this is not possible, the plan must be adjusted by the central traffic control. Changes in the normal train characteristics are likewise reported to the traffic control.

If the train departs late, continuous indications will be given to the driver on the display means, using the system and the method according to the present invention, as to when the driver must accelerate the train, when he must travel at a constant speed, cause the train to slow or brake in order to arrive at the destination exactly on time and with as little energy consumption as possible and/or as little wear to the brakes as possible.

Also when there is delay en route, for instance because stray cattle are on the track, the correct travel recommendation must be issued to the driver immediately so that the train arrives at its destination exactly on time and/or in the most efficient manner possible.

The present invention is not limited to the above described embodiments thereof; the rights requested are defined by the following claims.

Claims

1. Method for optimizing the travel performance, such as accelerating, travel at constant speed, slowing and braking, of a vehicle, wherein fixed data of a route for travelling is transferred over a distance from a traffic control to the vehicle at the start of the route for travelling and/or during travelling thereof and is stored in a computing means in the vehicle, wherein dynamic status data such as relate to the distance travelled and/or speed during travelling of the route is recorded and supplied to the computing means and wherein calculations are performed by the computing means in order to provide a recommendation for the travel performance of the vehicle.

2. Method as claimed in claim 1, wherein the vehicle is a rail vehicle.

3. Method as claimed in claim 1 or 2, wherein optimization takes place on the basis of the smallest possible energy consumption by the vehicle and/or the least possible wear on the brakes.

4. Method as claimed in claim 1, 2 or 3, wherein the fixed data is transferred remotely to the vehicle at the start of the route for travelling.

5. Method as claimed in any of the claims 1-4, wherein the travel recommendation is continuously made visible to the driver of the vehicle on a display means.

6. Method as claimed in any of the claims 1-4, wherein the travel recommendation is transferred directly to the drive means or brake members of the vehicle, but wherein the driver can if necessary still intervene in the travel performance of the vehicle, for instance from considerations of safety.

7. System for optimizing the travel performance of a vehicle, comprising:

- a computing means provided with storage means for storing fixed data concerning a route for travelling and/or characteristics of the vehicle, which computing means is arranged on board the vehicle; and
- measuring means for determining dynamic status data, such as distance travelled and/or speed of the vehicle during travelling of the route, wherein the measuring means are connected to the computing means; and
- communication means for transferring the fixed data to the computing means over a distance.

8. System as claimed in claim 7, provided with a display means for continuously displaying the travel recommendation to the driver of the vehicle.

9. System as claimed in claim 7 or 8, wherein the measuring means make use of external beacons such as satellites in order to determine position and/or speed.

10. System as claimed in claim 7, 8 or 9, wherein the measuring means comprise one or more rotation sensors for measuring the number of rotations of one or more shafts of the vehicle in order to determine the speed and/or the position thereof.

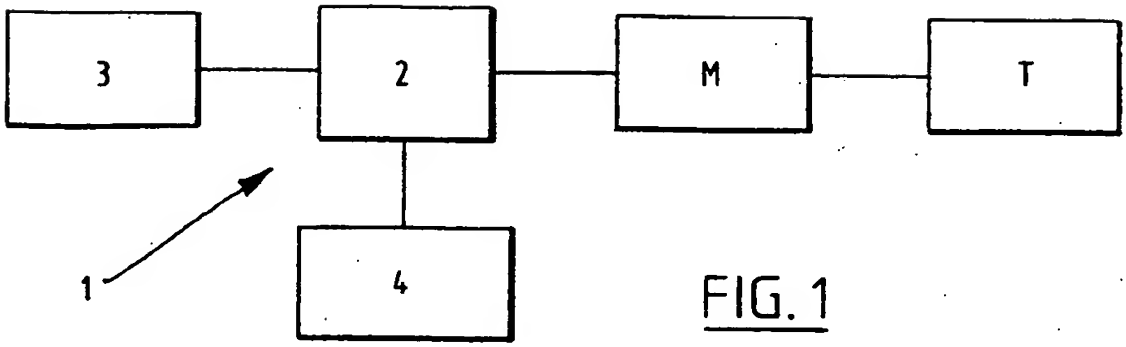

FIG. 1

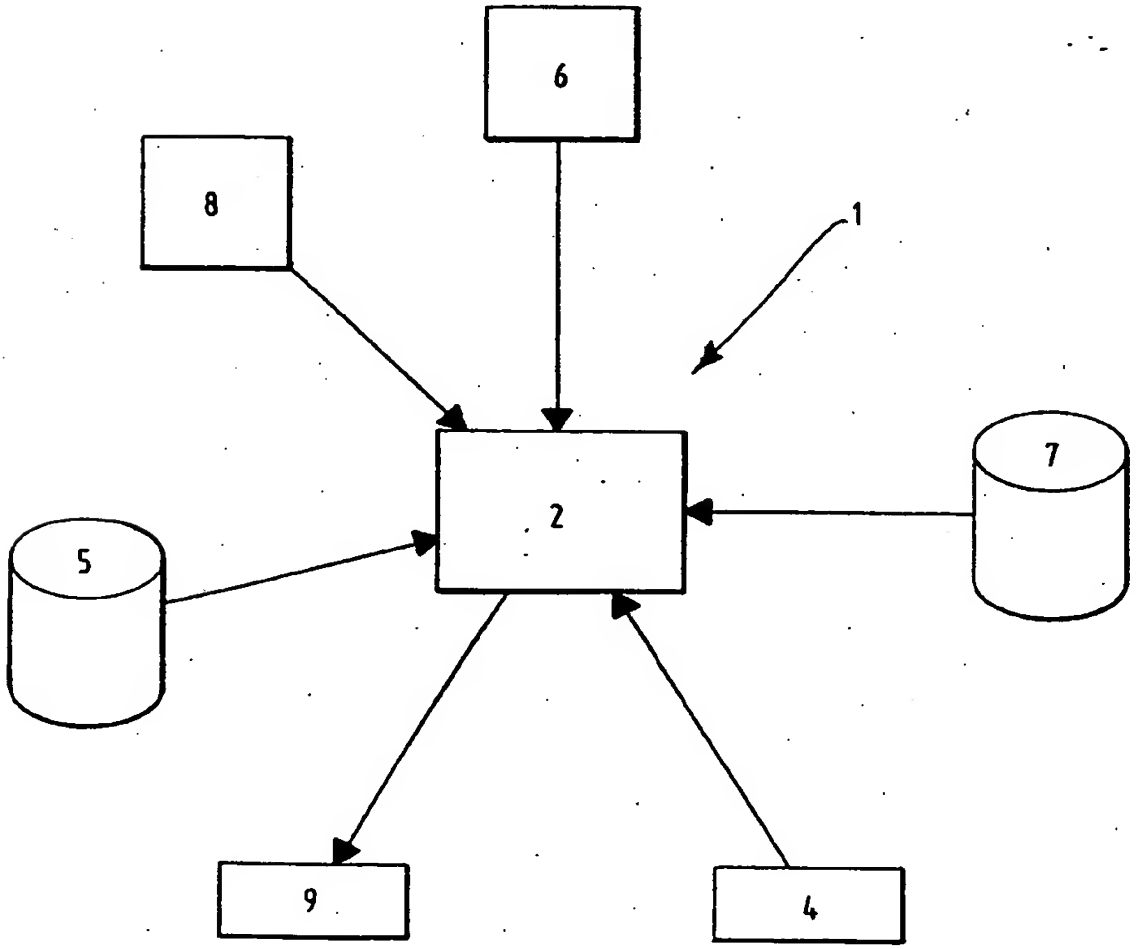

FIG. 2

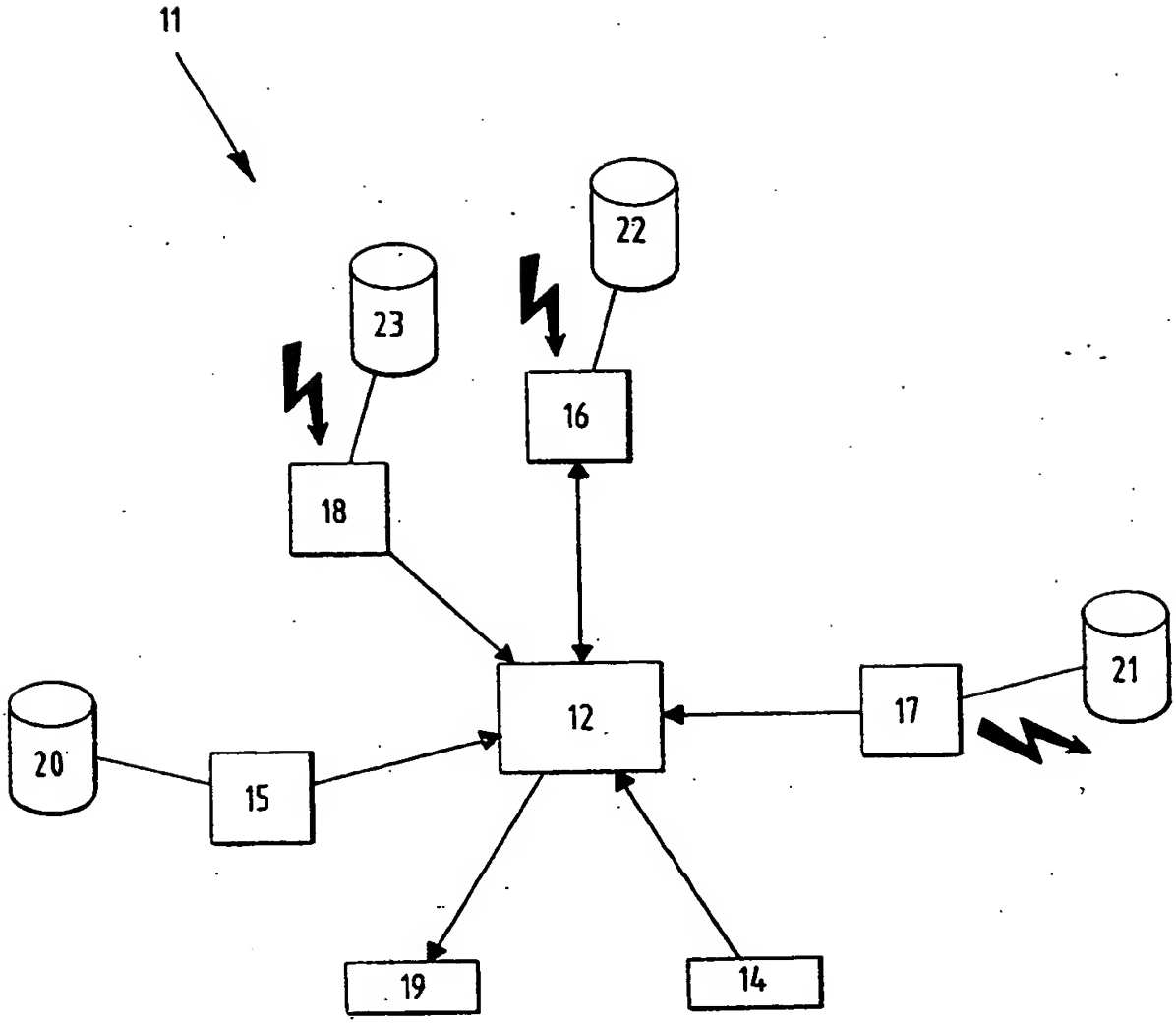

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 20 2134

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,X	EP-A-0 539 885 (KABUSHIKI KAISHA TOSHIBA) 5 May 1993 * the whole document *	1-10	B61L3/00
D,X	EP-A-0 615 891 (HITACHI, LTD.) 21 September 1994 * the whole document *	1-10	
D,X	WO-A-90 03622 (TEKNIS SYSTEMS (AUSTRALIA) PTY. LTD.) 5 April 1990 * the whole document *	1-10	
D,X	EP-A-0 114 633 (HITACHI) 1 August 1984 * the whole document *	1-3,6,7, 9,10	
D,X	EP-A-0 467 377 (HITACHI) 22 January 1992 * abstract * * page 7, line 21 - page 8, line 44; figures 11,12 *	1-3,7	
D,A	EP-A-0 554 983 (WESTINGHOUSE BRAKE AND SIGNAL HOLDINGS LIMITED) 11 August 1993		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B61L
B60L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 November 1996	Reekmans, M

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